

## DRAWINGS ATTACHED

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## (54) VERNIER INDICATOR

(71) I, DONALD HATCH, a British subject, of 10 Whaley Lane, Whaley Bridge, Stockport, Cheshire, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a vernier calibrated dial constituting an improvement in the dial disclosed in my British Patent Specification No. 1,250,475 of which claim 1 reads as follows:

"A vernier calibrated dial comprising first and second relatively rotatable parts, one of said parts carrying a circular main scale and the other an index against which the said main scale may be read, one of said parts bearing a circular second scale having the same angular spacing between its marking as the main scale, and the other of said parts bearing a circular vernier scale co-operating with said second scale, whereby the extent of relative angular movement of the parts is indicated to a first degree of accuracy by the position of said index against said main scale and to a second degree of accuracy of coincidence of markings on the second and vernier scales."

Such a dial reads to two degrees of accuracy, i.e. a first digit can be read off against the said index and the second digit can be read off the vernier scale. The object of this invention is to provide a dial which enables a third digit to be estimated, whereby the accuracy of reading is enhanced.

According to the present invention, there is provided a vernier calibrated dial comprising first and second superimposed parts one of which is rotatable relative to the other, one of said parts bearing a circular main scale and the other part bearing an index against which the main scale may be read, one of said parts also bearing a second scale having the same angular spacing between its markings as the main scale and the other part bearing a circular vernier scale co-operating with said second scale, said second and vernier scales being superimposed one upon the other and

the upper one thereof having markings such that the markings of the underlying scale can be seen therethrough, the markings and backgrounds so contrasting that in any relatively adjusted position of the two parts high contrast exists between the markings of the second scale which do not coincide with markings of the vernier scale and the marking of the second scale which coincides with a marking of the vernier scale, each marking of one of the said second and vernier scales being defined in its width between two edges which extend substantially radially, whereas each marking of the other of the said second and vernier scales is defined in its width between two edges of which at least one is inclined to the radial direction.

It will be appreciated that the point at which the or one of the inclined edges intersects one of the said two edges which extend substantially radial will move in the radial direction as the two parts of the dial are adjusted slightly (without changing the markings of the second and vernier scales which coincide). Therefore the position of this point can be used to estimate a third digit in the reading of the dial.

The invention will be described in more detail, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a side view of a vernier calibrated dial embodying the invention fitted to a potentiometer;

Figure 2 is a plan view of the dial, taken from the right of Figure 1;

Figure 3 is an enlarged view of the portion of Figure 2 enclosed in dot-dash lines and indicated at 3 therein;

Figure 4 is a view similar to Figure 3 showing an alternative arrangement of markings;

Figure 5 is a view similar to Figure 1 but showing the two dial parts coupled to the potentiometer in a different way;

Figure 6 is a semi-diagrammatic view of the dial members bearing the scales and the different arrangements of the scales which may be made on the two dial members; and

Figure 7 is a semi-diagrammatic view of an alternative arrangement for utilizing the dial.

Referring to Fig. 1, the vernier dial includes two main constructional components, namely a first, lower or under dial member 22 and a second, upper or top dial member 24. Figure 1 is a side view of the vernier dial as utilized with a potentiometer 21 having a rotatable shaft 23, the potentiometer being mounted on a support 25 with the shaft extending freely therethrough. The dial member 22 is fixed on the support with the shaft 23 also extending freely therethrough, and the dial member 24 is secured to the shaft. Upon rotation of the shaft and dial member 24, the scales which are on the dial members, as described below, co-operate to indicate the amount of relative rotation between the dial members and consequent extent of rotation of the shaft 23. The dial members are concentric with the axis 26 of the shaft.

The scales are produced on the faces of the dial members and the dial members are superimposed with the dial faces thus close together.

Reference is next made to Figure 2 which shows the dial members superimposed in plan view. The lower dial member 22 includes a first circular scale 30 which will also be referred to as the main scale, consisting of a circular series of radial lines or marks 32, and associated therewith at the outer ends thereof, numerals 34 from "0" to "10". The spacing between the lines 32 may be as desired, in the present instance  $30^\circ$ , except that there is a greater spacing from the final "10" line continuing to the initial "0" line.

The lower dial 22 also bears another scale which will also be referred to as a vernier scale or third scale, and which consists of a plurality of radial lines or marks 38 positioned at the periphery, and a series of numerals 40 associated therewith adjacent the inner ends thereof. The lines 38 in the vernier scale are ten in number, being numbered from "0" to "9" inclusive and spaced apart an angular distance greater than that of the spacing in the normal scale 30, namely  $33^\circ$ . The "0"'s in the scales 30 and 36 are in radial alignment, a matter to be referred to again hereinbelow. The vernier scale is read against a second scale on the upper dial member 24 as described below, and indirectly therethrough against the main scale. The main scale includes ten spaces between the lines 32 while the vernier scale includes ten lines 38 in accordance with the usual and desired decimal division in vernier indicators.

The lower dial member 22 may be of any suitable material and is preferably provided with a darg, e.g., black, background and preferably the lines 32, 38 are white or highly reflective for high contrast therewith.

The upper dial member 24 is preferably of colourless transparent material, the second scale

being provided by a circular series of black or other opaque sectors 46 spaced apart to transparent markings 48 in the shape of radial lines. If desired, the markings 48 may be formed by cut-out portions. This scale is of the same angular arrangement as the main scale, i.e., the markings 48 are spaced apart  $30^\circ$  and positionable in radial alignment respectively with the lines 32 of the main scale. The second scale is of greater radius than the main scale and constitutes an expanded scale relative thereto.

The dial member 24 has a transparent annular space inside the sectors 46 which exposes at least the greater part of the lines 32 of the main scale, and the numerals 34 associated therewith, as well as the numerals 40 of the vernier scale, while the markings 48 individually expose the lines 38 of the vernier scale. Preferably the dial member 24 is very thin, to eliminate or minimize parallax problems. The upper dial member 24 is provided with an index pointer 50 co-operating with the main scale.

The upper dial member 24 may be provided with a knob 52 for rotating that member or the knob may be omitted and the dial member 24 be rotated by gripping its periphery.

Figure 2 represents the relationship between the scales on the dial members 22, 24. Assuming an arbitrary measuring position in which the index pointer 50 is between the numerals "3" and "4" of the scale, and respective ones of the markings 48, 38 are in register at position "5" of the vernier scale as indicated by the arrow 54, the measurement indicated would be three angular spaces of  $30^\circ$  each and five angular spaces of  $3^\circ$  each, totalling  $105^\circ$  from the starting position. In this position, the line 38 of the vernier scale at position "4" is in front of the corresponding marking 48, while the line 38 of the vernier scale at position "6" is beyond the corresponding markings 48.

The device presents an extremely convenient and easy readout, the user can at a glance observe the position of the index pointer 50 relative to the numerals 34 in the main scale, and he can as readily observe the indicated vernier measurement by observing that numeral 40 in the vernier scale at which the markings 48, 38 are in register, eliminating the necessity for counting increments in the vernier scale. Because of the exposure of the numerals 34 and 40 through the central transparent space in the upper dial member, the user can easily and quickly read the measurement or setting. Only one vernier line 38 is indicated, and even exposed, at a time, rendering the device extremely easy to read.

It will be seen from Figures 2 and 3 that the lines 38 of the vernier scale are wedge-shaped, with their widest portion substantially equal to the width of the markings 48 whose two edges are radial lines. This arrangement

provides an advantage in that the observer can easily and accurately read out the indication, since if the widest part of the line 38 is fully exposed through the aperture 48, it is centred relative thereto. Additionally, the arrangement is such that if one line 38 is fully exposed, neither of those adjacent thereto will be exposed, but if either of the latter is partially exposed, the first will not be centred.

Figure 4 shows an alternative shape of scale lines. In this instance the lines 38 of the vernier scale are straight but disposed at an angle to the radial direction and each line intersects an edge of the marking 48 at a point which is radially positioned in accordance with the degree of registration therewith, i.e., when exact registration is achieved, the line 38 will intersect as shown at the location 54, while if it is not exactly registered it will intersect the left hand edge of the markings 48 radially inwardly or the right hand edge radially outwardly. The lines 38 in front of and beyond the subject line preferably are not exposed when the subject line is in full register, aiding in the observation of the subject line. If desired, the markings 38 may be very narrow lines, as indicated.

In Figures 2, 3 and 4, the markings 38 of the vernier scale are more widely spaced than the markings 48 of the second scale. Therefore the position 54 at which a vernier marking coincides with a marking of the second scale moves round the dial in the same sense as the upper member 24 is rotated, though at a much greater rate. Alternatively, the markings of the vernier scale can be less widely spaced than those of the second scale, in which case the position of coincidence 54 moves round in

the opposite sense to that in which the upper member is rotated. These two alternatives can be referred to as "like rotation" and "contra rotation" respectively.

The apparent movement of the vernier indication in "like" or in "contra rotation", is related not only to the difference in spacing between the markings of the vernier scale and the indicia of the second, expanded scale, but also to the relative rotation between the dial members. As noted above, in one form of construction (Figure 1), the preferred form, the dial member 22 is fixed and the dial member 24 is rotatably mounted, but the opposite relative rotation is possible, i.e., the dial member 24 fixed and the dial member 22 rotatably mounted. This is shown in Figure 6 wherein a device 56 has a shaft 57 driven thereby. The dial member 22 is fixed on that shaft and rotated therewith, but the dial member 24 is fixed in a suitable support having an aperture or window exposing the dial face thereof.

Referring again to the apparent movement of the vernier indication, for any given relative spacing of the markings in the vernier scale and the markings in the second, expanded scale, opposite relative rotation between the dial members produces respectively opposite apparent movement of the vernier indication 54. The following table sets out the possible combinations involving the different vernier spacings and directions of rotations of the dial members, and resulting apparent movement of vernier indicators. In the table "Vd" is - - Vernier scale, and "Ens<sub>d</sub>" is - - Expanded (second) scale.

40

45

50

55

60

65

70

75

I Lower MemberFixedUpper MemberMovable:

- a) bears expanded scale and index pointer

Lower MemberFixed:

- a) bears main scale and vernier scale

Rotation

$V_d > E_{ns_d}$  yields like rotation

$V_d < E_{ns_d}$  yields contra rotation

- b) bears vernier scale and index pointer

- b) bears main scale and expanded scale

Rotation

$V_d < E_{ns_d}$  yields like rotation

$V_d > E_{ns_d}$  yields contra rotation

II Upper MemberFixedUpper MemberFixed:

- a) bears main scale and vernier scale

Lower MemberMovable:

- a) bears expanded scale and index pointer

Rotation

$V_d > E_{ns_d}$  yields like rotation

$V_d < E_{ns_d}$  yields contra rotation

- b) bears main scale and expanded scale

- b) bears vernier scale and index pointer

Rotation

$V_d < E_{ns_d}$  yields like rotation

$V_d > E_{ns_d}$  yields contra rotation

The scales may be positioned on different ones of the respective dial members 22, 24, except that the main scale and the index pointer 50 must be on different dial members, and the second, expanded scale and the vernier scale must be on different dial members. Figure 6 shows the different arrangements of the scales as they may be provided on the different dial members. The arrangement of Figures 2 to 4 may be considered a first, and preferred, arrangement and those of Figure 6 alternative arrangements. In Figure 6a the main scale 32 and pointer 50 are as in the first arrangement but the vernier and second scales 38 and 48 are reversed. In Figure 10b the main scale 32 and the pointer 50 are respectively on opposite members relative to Figures 2 to 4, while the vernier scale 38 and second, expanded scale 48 are in the same positions as in Figures 2 to 4. Figure 10c shows both pairs of scales reversed relative to Figures 2 to 4, i.e., the main scale 32 is disposed on the upper dial member 24 and the pointer 50 on the lower dial member 22, and the vernier scale 38 is on the upper dial member while the expanded scale 48 is on the lower dial member. It will of course be understood that when the scales 38 and 48 are reversed, the markings of the vernier scale will be in the form of transparent lines.

Figure 7 represents diagrammatically the use of the dial for measuring. An input shaft 60 drives a gear train 62 and thereby rotates a shaft 20 which is connected with the movable one of the dial members 22, 24, the other being fixed to some support member (not shown). Thus the extent of rotation of the input member 60 is measured according to the vernier relationship. The central transparent portion of the upper dial member is circumferentially continuous and exposes all of the main scale and the numerals of the vernier scale and the user can quickly and easily observe all indications, namely the main digit measurements, the vernier digit, and the indication given by the radial point of intersection defined by the markings 38 and 48. The position of the index pointer 50 is quickly observable as is, of course, the pertinent vernier indication, this latter being the only one exposed and observable, as noted above. The "0" 's in these two scales being in alignment, as they are, accurately indicate the starting position and since these two scales are exposed completely circumferentially around the dial, full utilization of the dial can be made throughout 360°.

Another advantage of the dial is that since the vernier relation between the vernier scale and the expanded scale is shown at the periphery of the dial members, the subdivisions can be expanded widely spaced to an extent limited only by the diameter of the dial members.

Another advantage is that the dark sectors 46 and the light colour or reflective character of the markings 38 provide high contrast and render the dial more quickly readable.

Additionally, because of the high contrast between the black or dark, and the white or reflective, visual observation is rendered easy by direct or reflected light, eliminating the necessity of back lighting or special illumination. However, if it should be desired to utilize back lighting, the device is readily adaptable to that form. It is possible to reverse the colours or contrast, i.e., to utilize black where white or reflective is now used, and vice versa.

Although the spacing of the markings in the different scales is based on the decimal system, it will be understood that other spacing may be utilized instead.

#### WHAT I CLAIM IS:—

1. A vernier calibrated dial comprising first and second superimposed parts one of which is rotatable relative to the other, one of said parts bearing a circular main scale and the other part bearing an index against which the main scale may be read, one of said parts also bearing a second scale having the same angular spacing between its markings as the main scale and the other part bearing a circular vernier scale co-operating with said second scale, said second and vernier scales being superimposed one upon the other and the upper one thereof having markings such that the markings of the underlying scale can be seen therethrough, the markings and backgrounds so contrasting that in any relatively adjusted position of the two parts high contrast exists between the markings of the second scale which do not coincide with markings of the vernier scale and the marking of the second scale which coincides with a marking of the vernier scale, each marking of one of the said second and vernier scales being defined in its width between two edges which extend substantially radially, whereas each marking of the other of the said second and vernier scales is defined in its width between two edges of which at least one is inclined to the radial direction.

2. A vernier calibrated dial according to claim 1, wherein each marking of the said other scale is wedge shaped.

3. A vernier calibrated dial according to claim 2, wherein the apex of each wedge shaped marking points to the axis of relative rotation.

4. A vernier calibrated dial according to claim 1, wherein each marking of the said other scale is defined in its width between two parallel edges, each such marking having the form of a line inclined to the radial direction.

5. A vernier calibrated dial according to claim 4, wherein each said line is narrow compared with the width of each marking of the said one scale.

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FIG. 5.

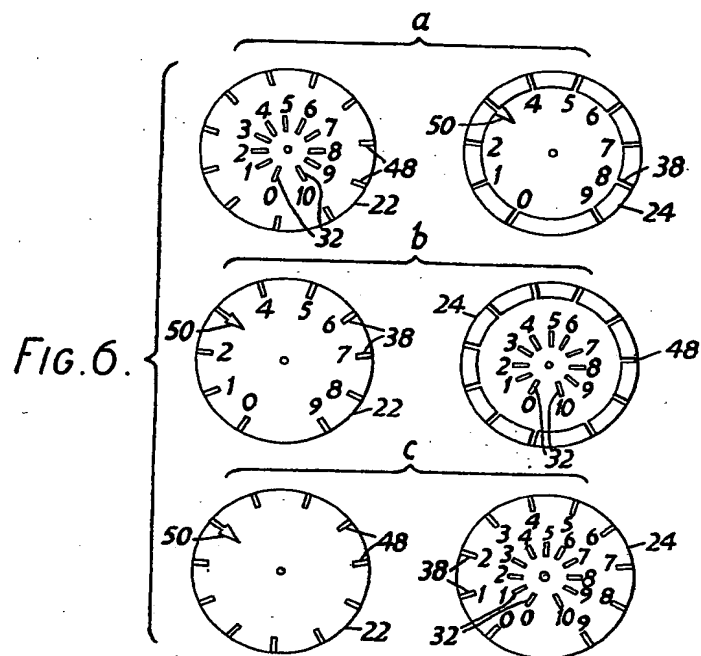
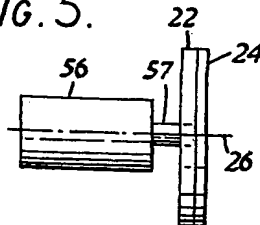


FIG. 7.

